The properties of homologous series (Item No.: P7172100)

Curricular Relevance

Area of Expertise: Chemie
Education Level: Klasse 7-10
Topic: Organische Chemie
Subtopic: Sauerstoffhaltige organische Verbindungen
Experiment: Eigenschaften der homologen Reihe

Difficulty	Preparation Time	Execution Time	Recommended Group Size
Easy	10 Minutes	10 Minutes	2 Students

Additional Requirements:

Experiment Variations:

Keywords:

alkanols, homologous series

Task and equipment

Information for teachers

Learning objectives

- The substances which belong to the homologous series of the alcohols exhibit common properties
- These properties change continuously with increasing number of carbon atoms.

Notes on setup and procedure

Preparation:
Should octanol or decanol be available, they can be additionally used in this experiment.

Remarks on the students experiments:
Ensure that the flame of the Bunsen burner is so adjusted that the alcohols in the test tubes can't ignite.

Hazard and precautionary statements

1-Propanol:

H225:	Highly flammable liquid and vapour.
H318:	Causes serious eye damage.
H336:	May cause drowsiness or dizziness.
P210:	Keep away from heat/sparks/open flames/hot surfaces – No smoking.
P233:	Keep container tightly closed.
P280:	Wear protective gloves/protective clothing/eye protection/face protection.
P305 + P351 + P338:	IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses if present and easy to do – continue rinsing.
P313:	Get medical advice/attention.

1-Butanol:	
H226:	Flammable liquid and vapour.
H302:	Harmful if swallowed.
H318:	Causes serious eye damage.
H315:	Causes skin irritation.
H335:	May cause respiratory irritation.
H336:	May cause drowsiness or dizziness.
P280:	Wear protective gloves/protective clothing/eye protection/face protection.
P302 + P352:	IF ON SKIN: Wash with soap and water.
P305 + P351 + P338:	IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses if present and easy to do – continue rinsing.
P313:	Get medical advice/attention.

1-Pentanol:	
H226:	Flammable liquid and vapour.
H332:	Harmful if inhaled.
H335:	May cause respiratory irritation.
H315:	Causes skin irritation.
P302 + P352:	IF ON SKIN: Wash with soap and water.

Hazards

- Some of the substances used are highly inflammable. Extinguish all open flames while handling them!
- Butanol is harmful to health. Do not inhale it or swallow it!
- Wear protective glasses!

Notes

Cetyl alcohol is (as palmitic acid ester) the major component of spermaceti. Insect waxes contain even longer chain alcohols. Myricyl alcohol, for example, is a mixture of $C_{30}H_{61}OH$ bis $C_{34}H_{69}OH$. With these alcohols, the unpolar character of the alkyl chain is predominant over the polarity of the hydroxyl group, so that these alcohols resemble the paraffins more than the alcohols in their properties (flammability, intermolecular forces etc.).

Remarks on the method

As some of the parts of the experiment are quite time-consuming, work-sharing can be used when there is a sufficient number of work groups. Either various alcohols can be examined for one property, or one alcohol is examined for various properties. Advanced courses: This experiment can be used for the discussion of the strength of the different intermolecular forces. It can also be used for the advanced discussion of solubilities in the context of tensides.

Waste disposal

- Pour alcohols into appropriately labelled containers for storage and re-use.
- Put alcohol-water mixtures into the container for combustible organic liquids.

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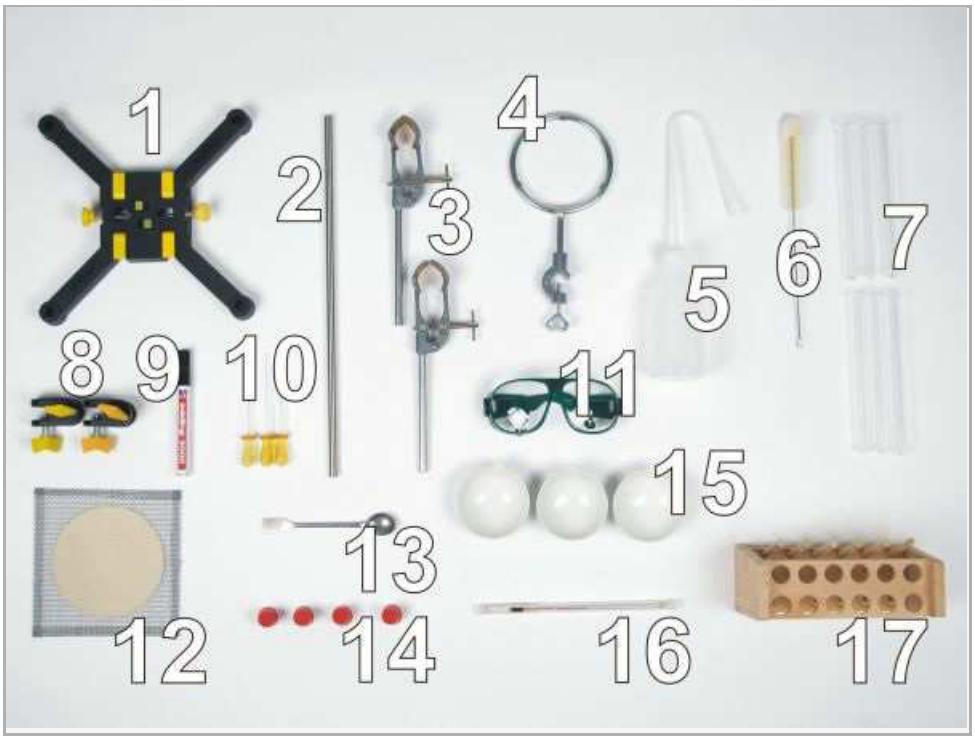
Task and equipment

Task

How do the properties of alcohols change with increasing number of carbon atoms?

Examine some properties of different alcohols.

Equipment



Position No.	Material	Order No.	Quantity
1	Support base, variable	02001-00	1
2	Support rod, stainless steel, l=370 mm, d=10 mm	02059-00	1
3	Universal clamp	37715-00	2
4	Ring with boss head, i. d. = 10 cm	37701-01	1
5	Wash bottle, 250 ml, plastic	33930-00	1
6	Test tube brush w. wool tip,d25mm	38762-00	1
7	Test tube, 180x18 mm,100pcs	37658-10	(6)
8	Boss head	02043-00	2
9	Labor pencil, waterproof	38711-00	1
10	Pipette with rubber bulb	64701-00	3
11	Protecting glasses, clear glass	39316-00	1
12	Wire gauze with ceramic, 160 x 160 mm	33287-01	1
13	Spoon, special steel	33398-00	1
14	Rubber stopper, d=22/17 mm, without hole	39255-00	4
15	Porcelain dish, 75ml, d = 80 mm	32516-00	3
16	Lab thermometer,-10..+150C	38058-00	1
17	Test tube rack for 12 tubes, holes d= 22 mm, wood	37686-10	1
	Butane burner f.cartridge 270+470	47536-00	1
	Butane catridge CV 300 Plus, 240 g	47538-01	1
	N-amyl alcohol 500 ml	31051-50	1
	N-butanol 250 ml	31142-25	1
	Water, distilled 5 l	31246-81	1
	Propyl alcohol,normal 250 ml	31754-25	1
	Boiling beads, 200 g	36937-20	1
	Wood splints, package of 100	39126-10	1

Set-up and procedure

Set-up

Hazards

- Some of the substances used are highly inflammable. Extinguish all open flames while handling them!
- Butanol is harmful to health. Do not inhale it or swallow it!
- Wear protective glasses!





Setup

Set up the stand as in Fig. 1 with a support ring and 2 universal clamps with boss heads. Put the wire gauze on the support ring. Position the Bunsen burner below the support ring and adjust the height of the ring so that the flame of the Bunsen burner just reaches the wire gauze.

Fig. 1

Number the test tubes from 1 to 6 and put them in the test tube rack. Put approx. 2 ml of propanol in the first test tube and the same amounts of butanol and pentanol in the second and third one (Fig. 2).

Fig. 2

Procedure

Using a pipette, put approx. 10 drops of propanol in test tube 4 and, using a fresh pipette each time, the same amount of butanol in test tube 5 and pentanol in test tube 6 (Fig. 3). Fill the test tubes 4 to 6 two thirds full with distilled water (Fig. 4). Close them with rubber stoppers and shake them vigorously (Fig. 5+6). Put them back in the test tube rack, wait about 3 minutes, then note what you observe.

Fig. 3

Fig. 4

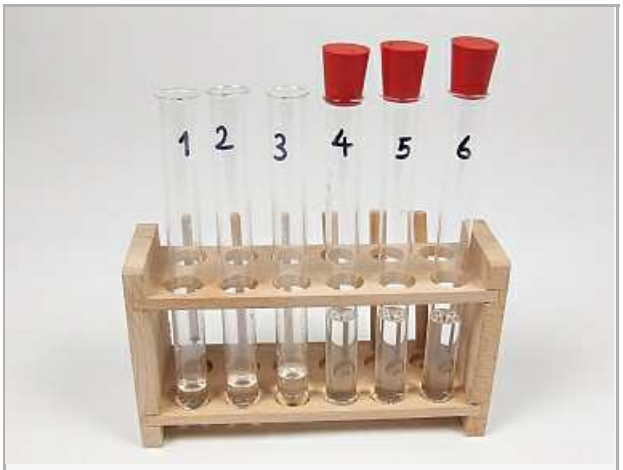


Fig. 5

Fig. 6

Put a few boiling stones in test tube 1, put it on the wire gauze and fix it in this position with the universal clamp. Fix the thermometer with the upper clamp so that it fits in the test tube. Adjust the height of it so that the bulb of the thermometer is about 1 cm above the level of the liquid (Fig. 7). Now carefully heat the wire gauze from below until the liquid begins to boil. The flame must not go near the mouth of the test tube!
Determine the boiling point of propanol.

Fig. 7

Repeat this procedure with the other alcohols in the test tubes 2 and 3.

When the test tubes 1, 2 and 3 have cooled down, take a little alcohol out of each of them with the appropriate pipette and transfer about 5 drops of each into separate porcelain dishes (Fig. 8). Remove the test tubes from the working area. Then try to ignite the alcohols with a burning wood splint.

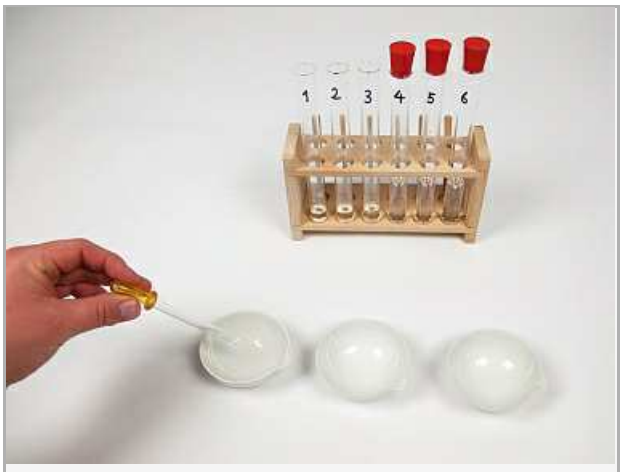


Fig. 8

Waste disposal

- Pour alcohols into appropriately labelled containers for storage and re-use
- Put alcohol-water mixtures into the container for combustible organic liquids.

Report: The properties of homologous series of alcohols

Result - Observations

Note your observations in general.

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Result - Table 1

Enter your observations in the table, supplementing them with the previously determined properties of methanol and ethanol.

Alcohol	Molecular formula	Solubility in water	Melting point in °C	Boiling point in °C	Combustibility
Methanol	CH_3OH	unlimitedly soluble	- 97		easily combustible
Ethanol	C_2H_5OH	unlimitedly soluble	- 114		easily combustible
Propanol	C_3H_7OH	unlimitedly soluble	- 126		easily combustible
Butanol	C_4H_9OH	soluble	- 90		easily combustible
Pentanol	$C_5H_{11}OH$	slightly soluble	- 79		combustible

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Evaluation - Question 1

Draw conclusions from your observations.

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Evaluation - Question 2

What can you say about the homologous series of the alkanes on the basis of these results?

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Evaluation - Question 3

Cetyl alcohol ($C_{16}H_{33}OH$) is a component of whale blubber, the longer-chain myricyl alcohol ($C_{30}H_{61}OH$) is a component of beeswax. Their properties vary greatly from the properties of the examined alcohols. Both are insoluble in water and are solid at room temperature. Explain the properties of these substances on the basis of the alcohols they contain.

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